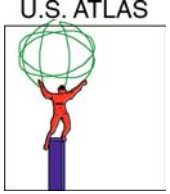
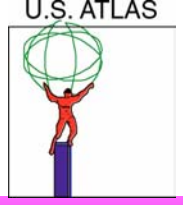


3.3 Liquid Argon Maintenance and Operations
4.3 Upgrade R&D

Richard Stroynowski

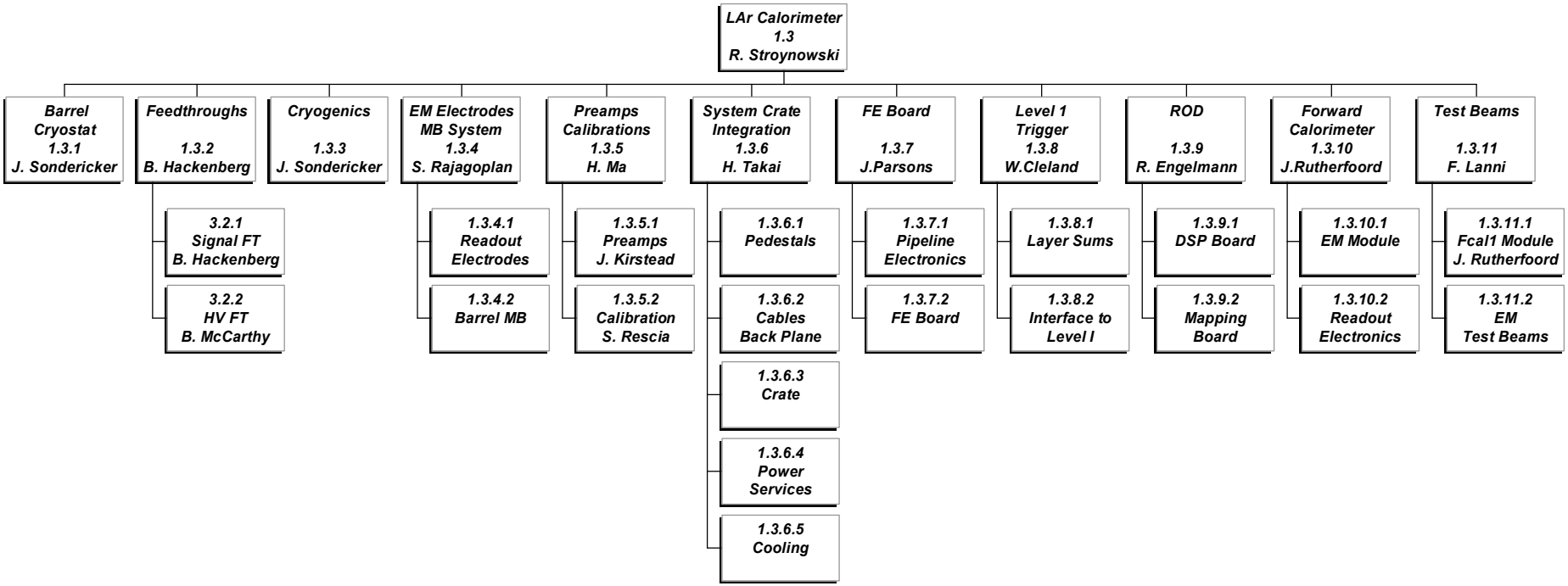
SMU



Outline

- Organization of subsystem and list of institutions
- Deliverables
- Status of construction
- Schedule
- U.S. responsibilities in M&O
- Upgrade R&D plans
- Conclusions

U.S. LAr Organization



US ATLAS Calorimeter Groups

Subsystem Manager

R. Stroynowski

Representatives on US Executive Committee

D. Lissauer, J. Parsons, J. Rutherfoord, R. Stroynowski

University of Arizona

T. Embry, K. Green, P. Loch, J. Rutherfoord *, A. Savin, L. Shaver, M. Shupe, M. Starr, D. Tompkins, P. Truncale

Brookhaven National Laboratory

C. Chen, H.A. Gordon, B. Hackenberg, S. Kane, J. Kierstead, F. Lanni, M. Leite, D. Lissauer*, H. Ma, D. Makowiecki, T. Muller, S. Norton, P. O'Connor, L.Premisler, V. Radeka, S. Rajagopalan, M. Rehak, S. Rescia, J. Sondericker, I. Stumer, H. Takai, K. Wolniewich, K.C. Wu, K. Yip

Columbia University (Nevis Laboratory)

J. Ban, C.Y. Chi, J. Dodd, R. Gardner, I. Katsanos, M. Leltchouk, S. Negroni, J. Parsons*, S. Simion, W. Sippach, A. Teho, W.J. Willis, L. Zhang

University of Pittsburgh

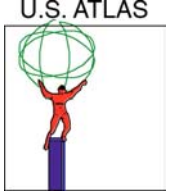
W.E. Cleland*, J. McDonald, B. Liu, V. Paolone, J. Rabel, V. Savinov, G. Zuk

Southern Methodist University
E. Barberio, G. Evans, Y. Gao, L. Lu, T. Liu, R. Stroynowski*, J. Ye, P. Zarzhitsky

University of Stony Brook
B. Botchev, J. Edgemir, R. Engelmann, R. McCarthy, R.D. Schamberger, M. Rijssenbeek*, J. Steffens, A. Talalaevskii, H. Themann, M. Thioye

University of Rochester
P. Slattery*

***Institutional Leaders**



Liquid Argon Calorimeter

US Responsibilities

1.3.1 Barrel cryostat+cryogenics

1.3.2 Feedthroughs:
Signal + High Voltage + Cables

1.3.3 Cryogenics

1.3.4 Electrodes + Mother Boards

1.3.5 Preamps

1.3.6 System Crates + Pedestals+Base planes
+Integration+Cooling+Slow controls

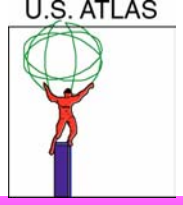
1.3.7 Front End Boards + Asics + Layer Sum boards + Optical Links

1.3.8 Level 1 Trigger Receiving System

1.3.9 Readout Drivers

1.3.10 Forward Calorimeter

1.3.11 Test Beams + Slow Controls + Detector Software



U.S. deliverables

- **Overall financial contribution:**
  - **~22% of the calorimeter system**
  - **~60% of electronics**
- **Most of the components for which US is responsible are active and require maintenance (with the exception of electrodes and FCal modules)**
- **Production is in good shape, its schedule is independent of CERN schedule changes**
- **Schedule of installation depends on the pit occupancy date and may slip by 3-4 month**

Barrel Cryostat

US is providing:

Design
Cold vessel (for calorimeter modules)
Warm vessel (solenoid)
Flanges, bulkheads, etc.
Insertion tools
Installation components
Slow controls

Status: At CERN in Bldg. 180
provisional acceptance

Cryogenics

US is providing:

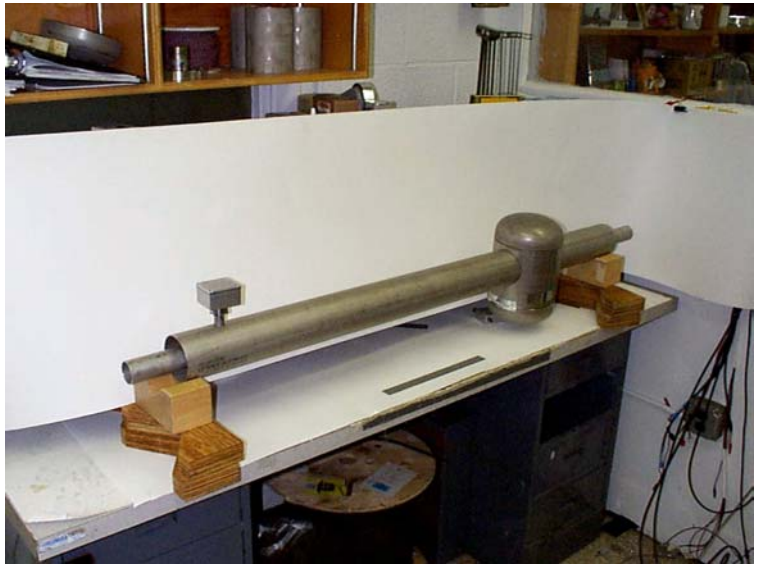
Refrigerator (located on the surface)
Nitrogen Dewar (located in the pit)
Interconnects
LN2 Quality Meters
Slow controls: temperature and pressure sensors, flow meters, etc.

- US will buy components, participate in commissioning and in installation.
- Engineering contribution to the integration: both in commissioning stage and in the pit, safety protection, etc.
- Control and monitoring software

Cryogenics

Status: of the LN_2 system:

- design complete
- Air Liquide (France) selected for manufacturing
- Apparent delay caused by the CERN schedule slip for the experimental hall availability
- Work concentrated on design of software control system
- Quality meters
  - measure gas/liquid ratio with 5% precision
  - 18 units built at BNL
  - "fill-time" production will be ready for summer



Signal Feedthroughs

High density connectors and cables to transfer signals from cold to warm

US is providing:

Overall design

Production of 64 Barrel Feedthroughs +spares

Components for Endcaps feedthroughs production

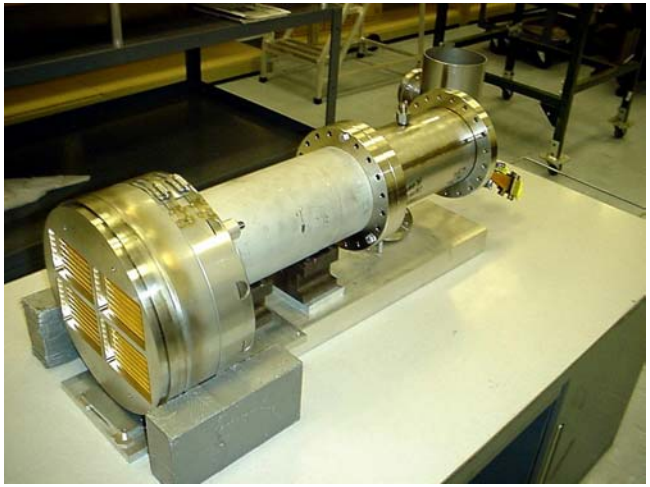
Installation

Commissioning

Slow controls

- temperature, pressure, gas flow

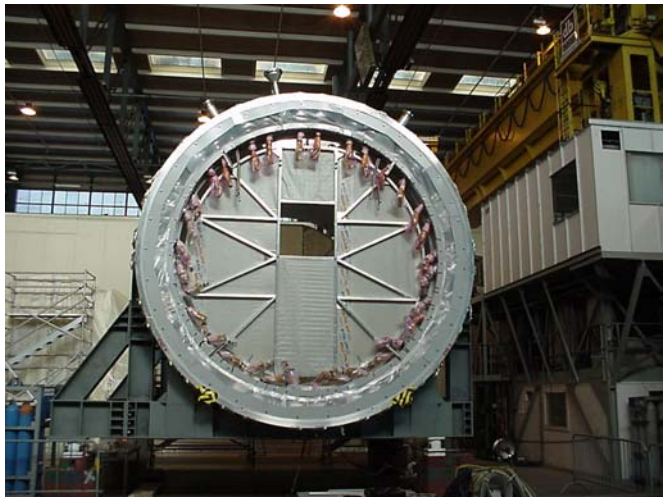
Engineering support



Signal Feedthroughs 2

Status:

Installation of signal feedthroughs on the barrel cryostat completed this week. Production of spares will be finished in 5 weeks.



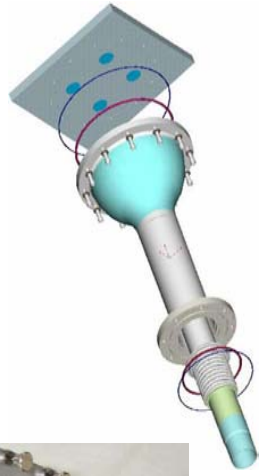
FTs Installed on the cryostat

HV Feedthroughs

6 High density warm to cold connectors and filters for HV cables (2 FT per each cryostat)

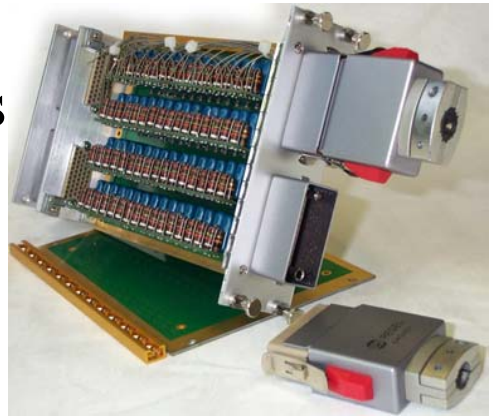
US is providing:

HV feedthroughs for barrel
and both endcap calorimeters
HV cables (8 x 840), HV Filter box
Installation, Commissioning
Monitoring



Status:

Mechanical components complete. Installation of cables in summer 02.

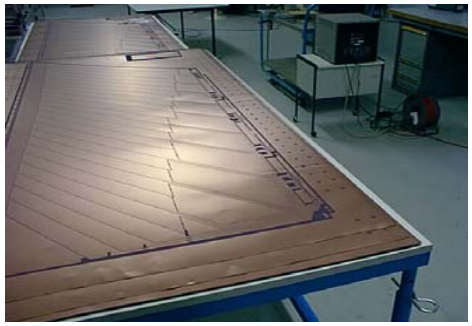


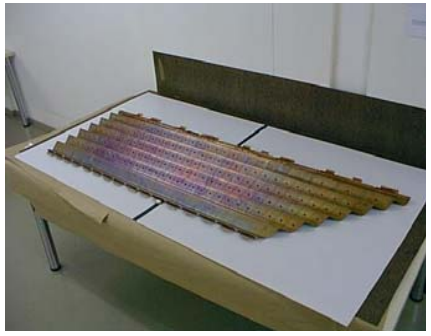
Readout Electrodes

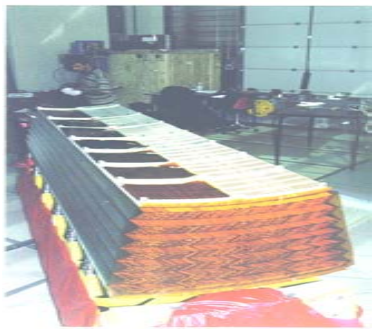
- Essential component of the em module production
- French/Italian/Spanish responsibility.
- US has a major financial obligation towards flat electrode procurement (managed by CERN)
- Production efficiency and schedule tightly coupled to the em module production and testing

Status:

- 10 out of 32 em modules completed
- Accrued schedule delay (6-9 month) mitigated by opening a third testing station at CERN (in addition to Saclay and Marseille)







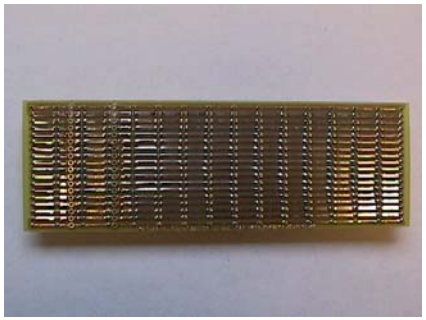
Mother Board System

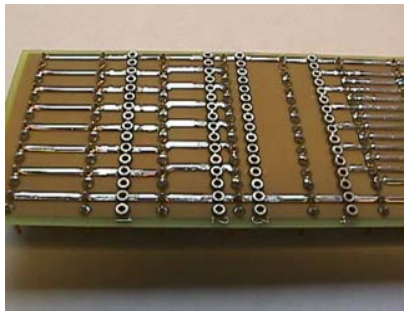
US is providing:

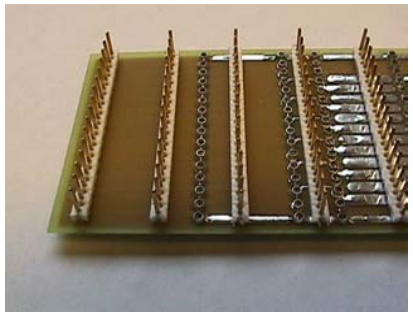
Summing boards, mother boards with calibration resistors and boards for HV distribution (over 25 different shapes)

New item this year – calibration network protection circuit

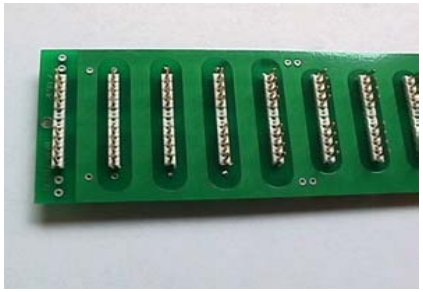
Status: production schedule matches module construction



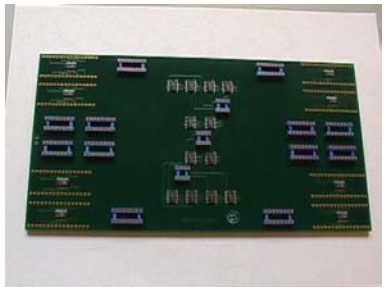




Summing Boards



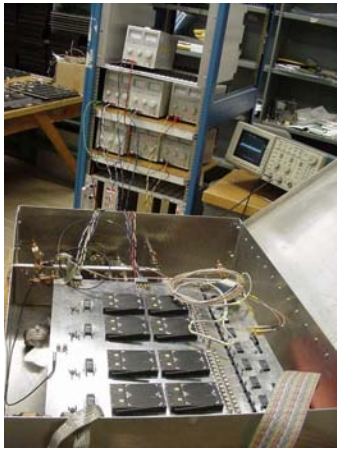
HV Boards



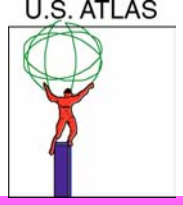
Mother Boards

Readout electronics-Preamps

- **US Responsibility:** 50% Preamps for Barrel EM and Forward (120K channels)
- **Status: Production proceeds well. Will be competed in FY02 ahead of needed date.**



Test setup



Readout electronics -FEB

US provides:

Overall design for barrel, Fcal and endcaps, DSM design of Asics, ADC, 50% preamps, "Personality" cards,
Asics production, cots, connectors, PCB, mechanical structures, fabrication and assembly
testing, installation, commissioning.
US is responsible for ~60% of the overall cost of front-end electronics and for 100% of the assembly and testing.

Concept – FEB is the same for all calorimeter
Practice - differences between barrel and endcaps
different parts of detector require different summations
Result - 25 different versions of the FEB

Readout electronics –FEB 2

Status:

All rad hard components exist with the exception of negative voltage regulators.

9 asics in DMILL and DSM fully tested

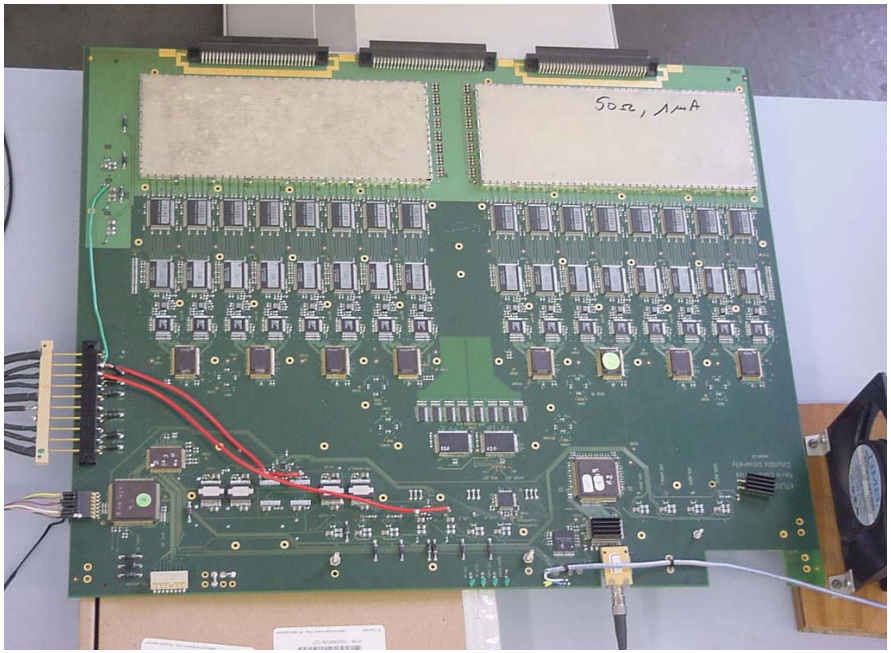
Prototype board assembled.

Full crate test (28 FEB+5 others) planned For Fall 02.

PRR scheduled for December 02 (tight but still possible).

Production in 03-04.

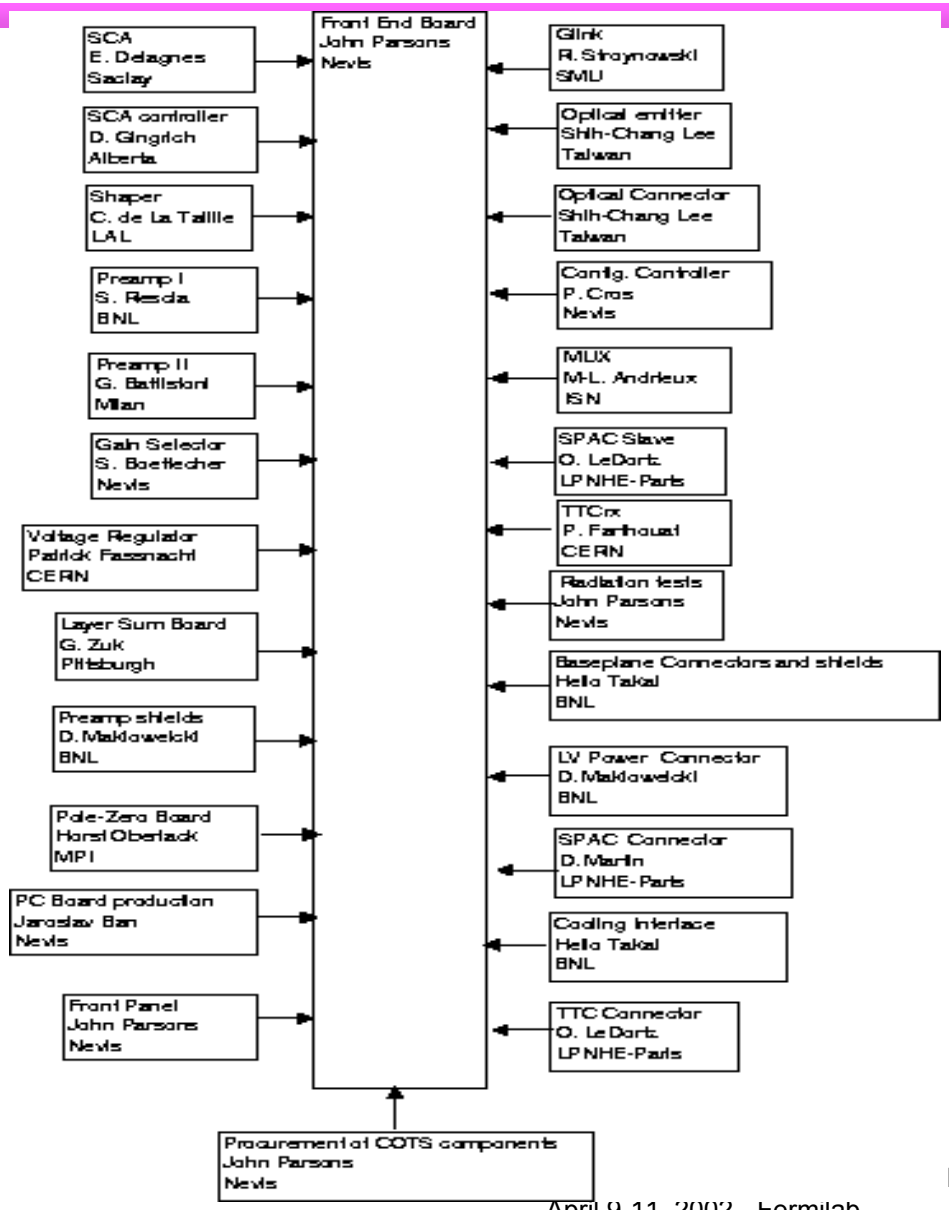
Installation/commissioning in the pit.



Pre-production prototype, no neg. VR's

U.S. ATLAS

FEB Responsibility Chart



Readout electronics-layer sums

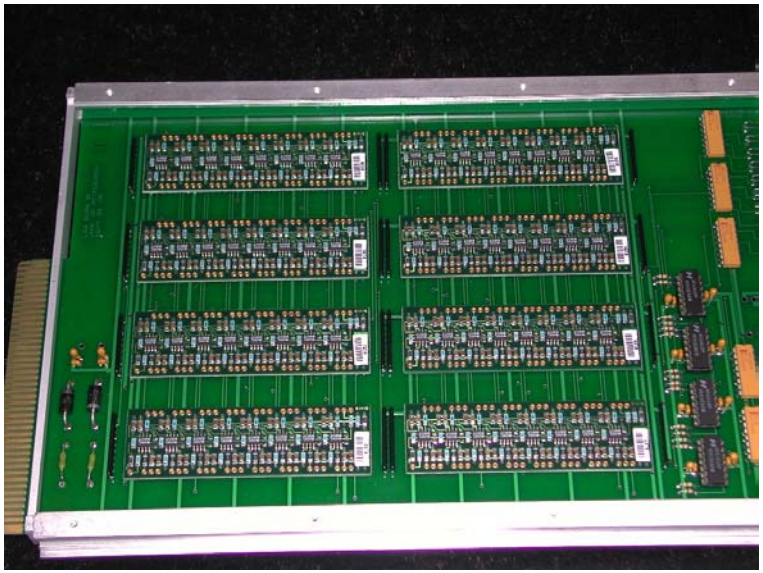
US is providing all Personality Cards to be placed on FEB's.

Different parts of the calorimeter require different summation schemes. Several types of boards were designed for barrel and endcaps.

Status:

Production started in Summer 2000 and is almost completed.

Production test setup



Optical Links

Provide data transfer between FEB and ROD:
Serializer, optical transmitter, fiber system, optical receiver, deserializer, control logic, monitoring software.

US is providing: Design, G-links, FEB integration ROD integration, control logic, monitoring software.(~40% of the components' cost.)

Status:
Overall system design complete. Production of transmitting and receiving sections depends on FEB and ROD schedule. FEB integration is complete, ROD integration will be completed in 2003.

Radiation test setup

Readout Drivers (ROD)

On-line DSP based processor system to extract energy and timing information at the input to DAQ, reduce data flow and implement calibration system. Design not yet completed. Production will have to be staged (see upgrade).

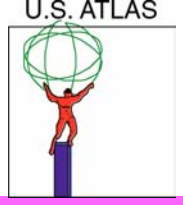
US provides:

Design, testing, 50% processing units (upgrade), operational and control software

Status:

Demonstration system based on DSP (Texas Instruments 64xx) and consisting of a Mother Board and Processing Unit was built in 2000. It has been tested in the BNL and CERN test set-ups. New prototype based on TI64xx series under evaluation. PRR and construction responsibilities will be assigned in summer 02.

Processing Unit



System Crate/Integration

US Responsibility:

All Barrel and EC electronics crates, Faraday cages, cooling plates, pedestals, warm cables, LV power supplies and power distribution, installation, testing and commissioning.

Status:

- **Pedestal, Crate, Power Bus – in production. (Zober Industries).**
- **Base plane and warm cables– exist. Installation (summer 02) will follow feedthroughs installation (same team).**
- **LV Power Supplies – radiation resistant prototype from Modular Devices exist, full unit under construction. Design has redundancy of individual modules. Local shielding of magnetic field in the crate region OK.**
- **Cooling plates – needed for FEB operations. Conceptual design complete, prototype tested. Japanese company producing early prototypes is no longer interested. New quotes are expected from an Italian manufacturer.**

System Crate 2

System Studies:

Full system (from "toy" calorimeter to ROD) working at BNL. Detailed system performance studies underway. Full size Mockup at CERN to study routing of cables and services.

Full crate studies of noise and cross talk scheduled for 2003.

Mock-up at CERN

Mock-up at BNL

Forward Calorimeter

US is providing :

Front sections of both Fcals, mother board system cold cables, cold electronics, trigger cables, tower driver boards, beam test module for calibration studies, installation, overall engineering support.

Status:

FCal C module completed.

Production of FCal A module started.

Cold electronics – in production.

Two Beam tests:

First in 2003 – calibration study

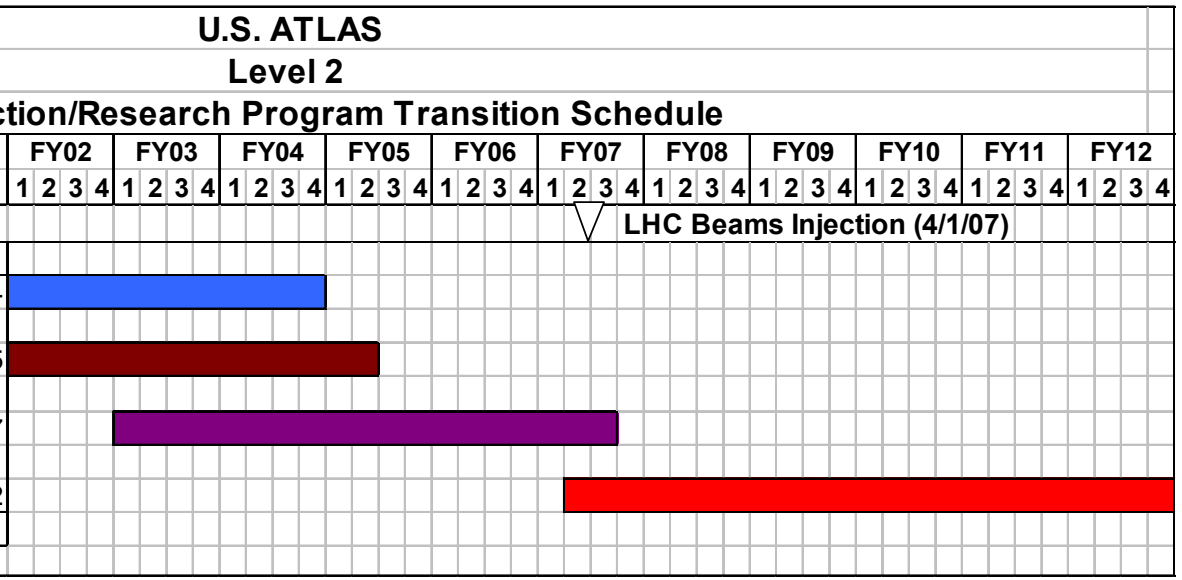
Second in 2004/5 – combined with HEC and EC

-will study tails of hadronic showers.

Schedule

U.S. ATLAS
Level 2
Construction/Research Program Transition Schedule

Subsystem	Category	Start Date	Compl Date
	Construction	N/A	10/19/04
	Installation	10/1/01	2/14/05
LAr			
	Pre-Operations	10/1/02	6/30/07
	Operations	1/2/07	9/28/12



M&O Concept

LAr system must be complete at the start of the experiment. This is required by order of installation and by the initial physics → full installation and commissioning is a necessary part of the project.

Procedure for bottom-up M&O estimate

- Follow US construction responsibilities
- Identify Liquid Argon subsystems and activities during pre-operations and operation stages.
- For each subsystem estimate the needs for materials and for a fraction of
  - Supervisory physicist (base)
  - Senior engineer
  - Technician/junior engineer
  - Software professional
  - Frequency of interactions needed
- Identify institutions which are willing to take on the responsibility
- FEB spares

Pre-operations

Calorimeter installation sequence:

- Initial installation in Building 180. Three separate cryostats with temporary cryogenics and controls.
- Signal, HV FT and pedestals installed in 2002.
- Calorimeter modules installed and cabled in 2003.
- Systems cooled down and tested in 2003/2004.
- Transfer from bldg.180 to the ATLAS pit in 2004.
- Installation of final cryogenics system+commissioning in 2005.
- Installation of Front End crates and electronics in 2005.

Pre-operations 2

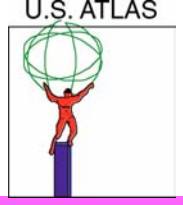
US responsibilities during the pre-operations will consist of

•Mechanical –

contribution to the operations of the cryogenic systems (pumps, sensors, monitors, consumables),
contribution to the HV and signal FT operations,
contribution to the transport (assumed at 20%) of the total
contribution to the pit installation and commissioning,
update of the documentation (separate for operations in bldg 180 and in the pit),
creation of the operations slow control data base (pressure, temperature, liquid levels, gas flow)

Pre-operations 3

•Combined EMEC/HEC/FCal beam test to calibrate tails of hadronic showers. Will require construction of special Fcal module to fit into the test cryostat.
•Long term burn-in of the Front-end system crate.
A complete crate of the front electronics will be operational During 2004-2006 for the study of the performance, noise and ROD integration problems.
•FEB spares – 22% of the CERN loan.
•Contribution to the common costs (assumed at 22% of the total) for maintenance of the bldg.180, equipment rental and general operations.



Operations

US responsibilities for maintenance and operations follow US deliverables.

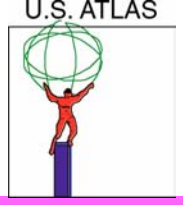
•In addition to the contribution to the day-by-day operations organized by personnel located at CERN and assumed to be at 22% of the total collaboration contribution to LAr, US must maintain the technical capability for testing and repairs of both mechanical components and of electronics components e.g., personnel located at CERN will be able to identify and replace a malfunctioning FEB, but any detailed repair will have to be done at Nevis.

•Maintenance of the operations data bases for systems with large number of computers will require software professionals.

•Each system will require fraction (depending on complexity) of an engineer, technician, software professional and supervisory physicist.

FEB Spares

Project (and original MOU) covers only the number of FEBs needed for the experiment. There is a need for spares during the operations of ATLAS. For practical and economic reasons it is cheaper to produce spares together with the all other FEBs. A CERN loan has been arranged to cover the cost and will be repaid by all LAr collaboration. US share is ~$312k and the re-payment is scheduled for 2005/2006.



U.S. ATLAS M&O Estimate
Liquid Argon WBS Level 4

Funding Source: All **Funding Type:** Program 4/3/02 8:18:05 AM

Institutions: All **Labor/Material:** Both

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
3	U.S. ATLAS M&O Estimate	208	673	1417	1825	3122	3059	3068	2880	2880	2880
3.3	Liquid Argon M&O Estimate	208	673	1417	1825	3122	3059	3068	2880	2880	2880
3.3.1	Pre operations and Commissioning	181	632	878	740	37	0	0	0	0	0
3.3.1.1	Electronics pre operations and com	0	509	840	601	37	0	0	0	0	0
3.3.1.2	Mechanics pre operations and com	181	122	38	140	0	0	0	0	0	0
3.3.2	Operations	0	0	104	460	994	946	858	670	670	670
3.3.2.1	Electronics Operations	0	0	104	104	635	586	530	342	342	342
3.3.2.2	Mechanical operations	0	0	0	355	359	359	328	328	328	328
3.3.3	Maintenance	5	30	309	315	1695	1741	1750	1750	1750	1750
3.3.3.1	Maintenance of electronic equipme	0	25	175	181	1493	1507	1541	1541	1541	1541
3.3.3.2	Maintenance of mechanical equipm	5	5	134	134	202	234	210	210	210	210
3.3.4	CERN living expenses	0	0	120	120	120	180	180	180	180	180
3.3.5	CERN common costs	22	11	6	190	276	192	280	280	280	280
3.3.5.1	CERN common costs	22	11	6	190	276	192	280	280	280	280

Labor M&O Summary FTEs by FY Research Program

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.3 | Funding Type: Program | 4/3/02 10:27:26 AM

Description: Liquid Argon M&O Estimate | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered Total
Faculty											.0	.0
Sr Research Scientist											.0	.0
Term Scientist											.0	.0
Post Doc									.0		.0	.0
Grad Student											.0	.0
Mechanical Engineer		.4	.1	1.6	1.6	1.7	1.4	1.4	1.4	1.4	10.9	.0
Electrical Engineer		.6	1.9	1.5	4.4	4.4	3.6	3.6	3.6	3.6	27.3	.0
Technicial	.5	2.7	2.3	2.3	4.6	4.1	2.9	2.9	2.9	2.9	27.9	.0
Computer Profession		.8	3.2	2.9	3.8	3.3	3.1	2.1	2.1	2.1	23.3	.0
Designer	.3	1.0	.7	.3							2.2	.0
Adminsitrator											.0	.0
Contract Labor									.0		.0	.0
TOTAL LABOR	.8	5.4	8.1	8.6	14.2	13.4	11.0	10.0	10.0	10.0	91.6	.0

Manpower increase from FY03 to FY 06 reflects manpower availability due to completion of the construction project.
Manpower decrease after FY08 reflects an expectation that M&O operations will become more efficient.

Labor Summary FTEs by FY Base/Infrastructure

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.3 | Funding Type: Base+Infrastructure | 4/3/02 10:31:07 AM

Description: Liquid Argon M&O Estimate | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered Total
Faculty	1.0	1.0	3.2	4.7	7.5	6.5	1.8	1.7	1.5	1.5	30.2	.0
Sr Research Scientist		1.0	1.0	1.1	1.1	.1	.1	.1	.1	.1	4.7	.0
Term Scientist	.1	.6	6.9	6.7	9.1	6.6	5.0	5.0	4.5	4.5	48.7	.0
Post Doc	.5	.5	3.5	4.2	9.2	8.7	5.1	4.4	3.9	3.9	43.8	.0
Grad Student			2.0	3.5	8.0	7.0	3.0	3.0	3.0	3.0	32.5	.0
Mechanical Engineer											.0	.0
Electrical Engineer											.0	.0
Technicial											.0	.0
Computer Profession				.3	.3	.3	.2	.2	.2	.2	1.8	.0
Designer											.0	.0
Adminsitrator											.0	.0
Contract Labor											.0	.0
TOTAL LABOR	1.6	3.1	16.6	20.4	35.2	29.2	15.2	14.3	13.1	13.1	161.7	.0

4.3 Upgrade R&D

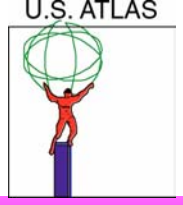
Two projects identified as R&D leading to upgrades

ROD upgrade R&D

Initial ROD system will be limited by the speed of DSP's to about 30kHz.
In order to handle full LHC luminosity projected for 2008, the ROD system will have to be upgraded to allow for a 75-100 kHz trigger. An R&D on the new versions of DSP is planned for 2006 to allow for an upgrade in 2007/2008.

FEB upgrade R&D

CERN plans include upgrade of the LHC luminosity by a factor of 10.
This will result in a corresponding increase of radiation levels in the area of front end crate and the presently designed readout boards will not survive. The upgrade includes a 4 year R&D on the design of electronics that can work in much higher radiation environment.



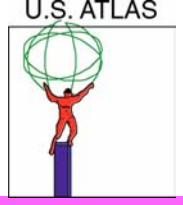
R&D Labor Summary FTEs by FY

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 4.3 | Funding Type: Program | 4/3/02 2:02:52 PM

Description: No description on file. | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered Total
Computing Profession										.0	.0	.0
Electrical Engineer Sr				1.5	2.0	2.0	2.0	2.0	2.0		11.5	.0
Electrical Engineer Jr											.0	.0
Mech Engineer Sr											.0	.0
Mech Engineer Jr											.0	.0
Design - Draft				1.0	.5	.5	.5				2.5	.0
Adm Support											.0	.0
Electircal Technician					1.0	1.0	1.0		.3		3.3	.0
Mech Technicial											.0	.0
Student											.0	.0
Physicist											.0	.0
Purchased Labor											.0	.0
TOTAL LABOR	.0	.0	.0	2.5	3.5	3.5	3.5	2.0	2.3	.0	17.3	.0

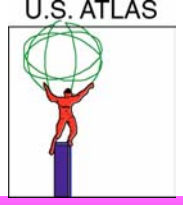


Upgrade R&D Profile

Upgrade R&D
WBS Profile Estimates

Funding Source: All
Funding Type: Program
4/3/02 2:22:20 PM
Institutions: All
Labor/Material: Both

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
4.3	Liquid Argon Upgrade R&D	0	0	0	560	526	526	526	379	398	0
4.3.1	R&D Upgrades	0	0	0	560	526	526	526	379	398	0
4.3.1.1	FEB Upgrade R&D	0	0	0	232	526	526	526	379	398	0
4.3.1.2	ROD Upgrade R&D	0	0	0	328	0	0	0	0	0	0



Conclusions

- LAr construction is proceeding well
  - Production follows US schedule (not CERN)
  - Installation depends on the pit availability and may slip few month
- Cryostat will start pre-operations in 2003
- Read-out electronics will become available in 2004/2005
- FCal/EMEC/HEC combined beam tests dates 2004/2005 are driven by CERN test beam schedule
- R&D on the faster DSP's for ROD system is necessary in order to reach full trigger capability of the read-out.
- R&D on readout electronics upgrade will phase-in at the end of commissioning